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IO AND ITS HABITS.

BY DR. JAMES LEWIS.

IN a mountainous region comprising adjoining portions of the States of Virginia, North Carolina, Tennessee, and Kentucky arise numerous small streams which unite to form the principal rivers which are the head-waters of the Tennessee River. All these streams, not excepting the upper portions of the Tennessee River itself, have in a greater or less degree the characters of mountain torrents, which in reality they seem to be on a very grand scale. The streams have very usually a rapid descent, and are in many places broken by shoals and rapids, the beds of the streams being usually coarse gravel or rock; there are seldom to be found stretches of placid water, and accordingly, as might well be conjectured, the fauna of the region, so far at least as relates to fresh-water mollusks, is somewhat peculiar. In the gravelly portions of some of the streams abound numerous species of Unio; on bars and shoals are found immense numbers of operculate univalve mollusks, and in the rapids, especially in rocky portions of the principal rivers, are found the beautiful and interesting shells of species of Io, which are the largest and most attractive univalves of the family to which they belong. The earliest account we have of this group of shells may be found in the *Journal of the Academy of Natural Sciences*, November, 1825, in which Mr. Say described a species found in the North Fork of the Holston River in Virginia, calling it *Fusus fluvialis*. From that time until quite recently, additional species have from time to time been published, all of them being referred to the Holston River or more vaguely to "Tennessee." Even so late as 1873, there was only a single record showing that Io had been found in any stream other than the Holston River. The record here alluded to occurs in the *American Journal of Conchology*, vi. 223, and bears date October

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24, 1870. If there were any persons aware of the occurrence of Io in streams other than the Holston River prior to that date, they probably had reasons for not publishing the fact. Since the date quoted, however, it has been ascertained that the distribution of Io extends to several streams in East Tennessee, rendering it quite probable that future explorations may lead to its detection in the southern part of Eastern Kentucky, and in the northern part of Western North Carolina. At the present time Io is known to occur in the following streams: North Fork of the Holston in Western Virginia; in the Holston River in East Tennessee; in the Tennessee River as far south as Bridgeport, Alabama; in the Nolachucky and French Broad rivers in Jefferson County, Tenn.; in the Clinch River at Black's Ford, Anderson County, Tenn., and at Williams' Ford in Roane County, Tenn.; and in Powell's River at Kraushorn's Ferry, near the State of Kentucky.

Observers who have made any records of the habits of Io agree in stating that the shells are found only in swift water, though there appear to be discrepancies as to the abundance of specimens, which may indicate that some localities are more favorable for them than others. It must be inferred that Io, living in streams the currents of which are very rapid, is specially organized, and adapted to the situations in which it is found. Such, indeed, seems really to be the case; for a lady who collected specimens in some of the rivers of Tennessee wrote of them as follows: "The muscular power of Io is astonishing. I frequently find one adhering to a rock half as large as my head, and when I take up the shell it brings the rock with it, and requires much force to separate it." [1]

It is somewhat strange that shells of so much beauty as some of the species of Io display are scarcely known to the inhabitants dwelling in the neighborhood of the streams in which they occur; yet it seems, from records made of the contents of ancient burial places, that they were known to the people who inhabited the country prior to the advent of European races. Mr. Lea, writing upon this subject,[2] makes the following suggestive remark, which conveys a great deal in a few words: "Professor Troost informs me they [Ios] are rare in the river [Holston]; that they had been observed in the graves of the aborigines; and as it was generally believed that these were 'conch shells,' consequently coming from the sea, it was urged that the inhabitants who possessed them must have come over the sea. It does not appear that they [Ios] had been observed in their native element, though living at the very doors of the persons who had remarked them in the tumuli." The impression that Io is a "sea-shell" is one that strikes most ordinary observers at first sight, as every collector who has them can testify.

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[1] American Journal of Conchology, vi. 223.

[2] Observations, etc., i. 224.

Quite a considerable number of species of Io may be found described and figured in various works treating on the shells of North America, and there is considerable diversity exhibited in their forms, sizes, colors, and markings. There seems to be considerable difference of opinion among persons who have studied these shells, as regards the number of species. There are some individuals who with apparent good reason believe that there is really only one species of typical Io, to which all the forms are subordinate as varieties; while on the other hand we shall find others who for reasons quite as good insist that there are five or more "good species." The shells, taken by themselves, without regard to any facts relating to their habits, do not afford conclusive testimony as to species, as it is exceedingly difficult to isolate forms that cannot be made part of a continuous series when large numbers of shells are placed together. There are, however, some facts connected with geographical distribution and the association of varied forms, which seem to indicate conclusively that there are certainly two species; and, this being admitted, the logical inference might be, under all the circumstances which remain unconsidered, that there are more than two species. This, however, is a question which remains to be investigated. The facts upon which two species are inferred are the following. At Black's Ford, Clinch River, Anderson County, Tenn., two forms of Io constitute very nearly all that are found at that particular locality, and these two forms occur there in about equal numbers, and there are not associated with them any intermediate forms uniting the extremes. Thirty or forty miles down the river (following its winding course), at Williams' Ford in Roane County, these same two forms reappear, but their relative numbers have changed. At this point the form which seems to be identical with a shell figured by Reeve as *Io turrita* (not Mr. Anthony's species of that name, by any means) is the shell occurring in fewest numbers, while the prevailing form is a graceful, slender variety of the shell that Mr. Lea calls *spinosa*. The change in the relative abundance of two forms by a change of station seems to afford evidence relative to species. In following out the train of ideas which this suggests, it is perhaps appropriate in this connection to glance at the subject of geographical distribution as it relates to other forms, and suggest some of the conditions that seem to be correlated to the diverse forms. A little reflection will satisfy the most casual observer that the conditions under which Io is found are subject to variations of no small magnitude. First to be considered is the climatic condition, affected by the combined influences of latitude and elevation, conspiring in the northern limit of the region inhabited by Io to produce a lower mean annual temperature than may be inferred at the southern limit. There may be in all a difference of four or five degrees of latitude, and possibly from two hundred to four hundred feet difference in elevation. In the northern portion of the area inhabited by Io are found those forms destitute of spines, associated with others in which the spines are only rudimentary or reduced to mere tubercles. To the southward, the smooth forms diminish in numbers, and disappear entirely before the central latitude of Tennessee is reached, and as a warmer climate is approached the development of the spines becomes more and more luxuriant. This is true of the Holston River in Virginia and Tennessee, and recent observations have detected a similar state of facts in the Clinch River and its tributary, Powell's River. Besides the influences of climate dependent on latitude and elevation, it may be conjectured that there are other influences affecting Io, some of them in a considerable degree depending on the mineral properties of the water due to the variable qualities of rock and soil among the mountains of that region. In evidence of this may be suggested the differences in size and appearance of shells from different streams.

In correlating these differences we shall find the most robust Ios in the Holston River. The roughest shells, as regards the whole surface, occur in French Broad River. The most slender and graceful forms are found in Clinch River. The smallest adult forms occur in Powell's River, where there are also other peculiarities observable that contrast curiously with what is known of Io elsewhere. The tubercular and spinous forms of Powell's River exhibit their characteristics (spines and tubercles) in a more rudimentary form than those found else where, and on averaging the specimens it will be observed that they appear to have one whorl less, and more spines or tubercles on each whorl, than is observable in the more luxuriant forms of other localities. How much of all the differences in forms here suggested is ascribable to species is not at this time a subject of inquiry. In color, the shells of French Broad River are remarkable for green tints in the epidermis. In the Holston River the tints are somewhat ferruginous, but not to the same extent observable in the shells of Powell's River; while in Clinch River the epidermis is often of a bright yellow or orange, varied by livid tints which are partaken of by many other univalve mollusks inhabiting that stream.

The reader may possibly have felt, in reading a portion of this paper, some curiosity to know why Io occurs only in the upper waters of the Tennessee system of drainage. In the introductory paragraph of this paper it was stated that "all these streams, not excepting the upper portions of the Tennessee River itself, have in a greater or less degree the characters of mountain torrents, which in reality they seem to be on a very grand scale." From what we now know of Io we may infer that it cannot exist in placid rivers, and the limit of its distribution south in the Tennessee River depends on the character of the river. At the point where the Tennessee begins to be a majestic, placid stream, there Io ceases to extend its domain. This very simple inference is a key to the solution of other problems relating to the geographical distribution of allied forms in the same great family of mollusks. Very many of the univalve mollusks of the Tennessee drainage abound in swift shoal water, among rocks over which the water flows in broken torrents, and nowhere among still waters. The Tennessee River at Mussel Shoals is very prolific in various forms of mollusk life which delight in a rapid current; but below that point, in the navigable portions of the stream, very many of these interesting species disappear, because the conditions are no longer favorable to their existence.

Thus far, in the main, only the typical Io has been considered. There is another group of shells very nearly allied to Io, known by the generic designation *Angitrema.* Mr. Reeve regarded these shells as properly belonging in the genus Io; but his views do not seem to have met with much favor by writers on American conchology on this side of the Atlantic. Notwithstanding this evident difference in opinion, there is much reason for believing that Mr. Reeve's position is a good one, for some of the species of Angitrema are apparently related to Elk River, the Cumberland River, and some of its tributaries, as Io is to the head-waters of the Tennessee River. Indeed, it appears to be true that near the point where Io begins to disappear in the Tennessee River in Alabama, some of the forms of Angitrema replace it. The question of the relative geographical distribution of Io and Angitrema, taken in connection with obvious resemblances in the shells detected by Mr. Reeve, seem to favor the suggestion that Angitrema is but a minor phase of Io. In habits the animals, so far as is known, are somewhat similar to each other, with this difference, that Angitrema is fitted to dwell in more quiet waters than the necessities of Io require.

Taken in another aspect, the inquiry why Io should be confined apparently to the head-waters of the Tennessee River can be answered (in the proverbial Yankee style) by offsetting the inquiry why a curious group of shells with a fissured lip should be found only in the Coosa River in Alabama. This, like much more that might be made the subject of inquiry, is a part of the unwritten history of Io that remains to be investigated.

The reader who may desire to refer to a summary of what has been written on species of Io will find such information as is available for the purposes of a naturalist in a work entitled Strepomatidæ, by G. W. Tryon, Jr., Smithsonian Miscellaneous Collections, No. 253.

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A POPULAR EXPLANATION (FOR THOSE WHO UNDERSTAND BOTANY) OF THE MATHEMATICAL NATURE OF PHYLLOTAXIS.

BY THE LATE CHAUNCY WRIGHT.[1]

TAKE, by the finger and thumb of your right hand, hold of a spike of *Plantago major*, *Lepidium Virginicum*, or other flower-cluster with symmetrically crowded flowers, and with the finger and thumb of the left hand grasp it a little higher up, so as to include between the two hands a dozen or twenty buds on a piece of stem about equally tough from end to end. Twist the stem, and if it twists equally in all parts you will bring your buds into a small number of ranks, let us say 8. By twisting a little in the opposite direction you will get them into 5 ranks. Twist harder, and if your stem is tough enough to stand the twist you will bring them into two ranks. Turn back to 8 rows, and twist harder in that direction ; you will fetch your buds into 3 rows. Then twist still harder in that direction, and if you have an old, tough, plaintain spike, you may get the seed-vessels all into one row before your stalk is twisted off.

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[1] This article was prepared by Mr. Wright several years ago, at Professor Gray's suggestion. In its manuscript form it has been found of much interest and value to the botanical students in Harvard College. It is here reprinted without change from Mr. Wright's notes.